

NTP seminar explores functional ecology

By Eddy Ball

An ongoing lecture series sponsored by NTP made an unexpected turn into animal ecology Dec. 10 with a talk at NIEHS by zoologist Vladimir Vershinin, D.Sc.

Hosted by Biomolecular Screening Branch Chief [Ray Tice, Ph.D.](#), the talk, on "Amphibian Populations in Urban and Natural Environment in Urals," explored the impact of urban pollution and ecological changes, in and around the industrial city of Yekaterinburg, Russia, to frogs, newts, and salamandrella.

Tice, who leads the Tox21 predictive toxicology initiative for NTP, said afterwards, "This was a different kind of talk - one we're not used to hearing." But, he added that seeing these effects, on what many consider a sentinel species, may offer insight into the kinds of changes in biochemistry, morphology, life span, and reproduction that chemicals may produce in human populations.

Studying amphibians for 36 years

Vershinin is a professor and department chair of zoology at Ural Federal University in Yekaterinburg, whose group has gathered and analyzed data on amphibian populations at 26 geographical locations along the land border between Europe and Asia since 1977. He is also head of the Department of Functional Ecology of Terrestrial Animals at the Institute of Plant and Animal Ecology of the Russian Academy of Sciences.

Early in his talk, Vershinin described a central premise behind these studies, saying, "Amphibians are a prototype of terrestrial vertebrates... [whose] development is strongly affected by environment." He described the associations between the amphibian's skeletal structure, fertility, rate of physical abnormalities, and cardiac function over the past three decades with increased urbanization.

The down side of urbanization

Vershinin's group divided Yekaterinburg, Russia's third largest city, into four zones, by levels of development and density, ranging from the city center to forestland. The team analyzed water chemistry, average temperature, and a broad range of responses and outcomes over time in these areas.

The researchers collected data on changes in relative liver mass, sexual differentiation, skin permeability, and cardiac function, specifically isometrical myocardial force and myocardial contraction. They also observed changes in reproductive strategy, finding changes in onset of puberty, body length, and size, as well as fertility and egg size. A few of the changes helped amphibians adapt to a more threatening environment, but most were almost exclusively negative in terms of impact on population survival.

Some of Vershinin's most dramatic examples involved external and internal



"The Urals represent a complicated biochemical situation," Vershinin said at the beginning of his talk. "Yekaterinburg is one of the Uralian cities that appeared as a settlement around [metallurgical and heavy machinery] factories ... which are some of the complicated sources of pollution." (Photo courtesy of Steve McCaw)



Among his many slides of dramatic changes in the amphibian population was the one above, which shows anomalies in egg clutches among the outlying population of Siberian salamanders living in and around Yekaterinburg. (Photo courtesy of Steve McCaw)

abnormalities that reduced the quality of the population. Dramatic changes in egg clutches and ovarian symmetry contributed to low fertility. The researchers observed significant changes in eye pigmentation, the number and form of fingers and toes, and internal skeletal formation.

The amphibians' relationships with other organisms in their environment also changed, with an increase in cysts and a higher percentage of eosinophils, or white blood cells, reflecting a rise in parasite infection.

Detailed observations, but few clear associations

The strength of Vershinin's data collection was its long-term comprehensive monitoring. While the NTP scientists in the audience were impressed by the collection of large amounts of data in the studies, naturally as toxicologists, they wanted more.

Vershinin pointed to likely causes, such as lead and a strong association between some of the abnormalities and radioactivity. When he was questioned about effects of some of the chemicals that are of interest in several NTP studies, such as endocrine-disrupting compounds, Vershinin conceded the limitations of his observational approach and how much work remains to be performed.

"We still have some gaps in our knowledge on the evolution of amphibian populations," he told the audience. But, as people at the talk seemed to agree, Vershinin's group has created a model for gathering and analyzing the data - the important first step in conducting a comprehensive study of population to ultimately tease out the health effects of exposure to a mixture of multiple chemicals and other environmental factors.



"This is one of those kinds of seminars that occur because somebody knows somebody who happens to be visiting here," Tice said in his introduction. In Vershinin's case that somebody was NIEHS grantee [Alexander Kinev, Ph.D.](http://incellbio.com/), (<http://incellbio.com/>) of Creative Scientist Inc. Vershinin was a visiting scholar at NESCent, the National Evolutionary Synthesis Center, in Durham, N.C., presenting talks on his research and future plans for building a publicly accessible database. (Photo courtesy of Steve McCaw)

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